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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Steam Cylinder Lubrication in Industry

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Steam Cylinder Lubrication in Industry

Steam cylinder lubrication is so broad a subject that it should not be confused by attempting to cover the entire topic in blanket form; so, this article is devoted to Industrial Steam in Stationary Power Plants where the requirements imposed upon steam cylinder oils are controlled by a comparatively normal range of operating conditions.

It is not proposed to confuse the issue by including railway requirements nor the lubrication of marine steam engines.

Each involves its own particular type of operating conditions, which in turn, require specific consideration.

THE steam engine is unique in that it depends upon steam to complete the cycle of lubrication. In other words, steam cylinder oil is not applied directly to cylinder walls or valve surfaces, it must be distributed by the steam after the latter has been charged or impregnated with oil from a lubricator in the main steam line adjacent to the valve chest.

A steam cylinder oil must lubricate every sliding surface which is either in direct contact with the steam, or subject to its pressure and temperature. Engine design as it involves steam valves, valve rods, slide valve seats, cylinder walls, pistons, piston rings, piston rods and throttle valves, must therefore be carefully considered. These parts are not always subject to the same pressure and temperature conditions, yet the one oil must serve throughout, and, therefore, it must be sufficiently flexible in operation to produce efficient lubrication wherever necessary.

When steam temperatures ranged below some 400 to 500 degrees Fahr., selection of a suitable steam cylinder oil usually required but a simple routine of determining the moisture-content of the steam, the pressure and what use was to be made of the condensate.

As industry progressed, however, engines were developed to use steam of much higher temperatures. This increased the efficiency, added to power output and improved the fuel economy. Today steam pressures up to around 1800 pounds are not unusual. Superheating adds to the heat content so that present-day steam temperatures may approach 800 degrees Fahr.

Nature of the Oil

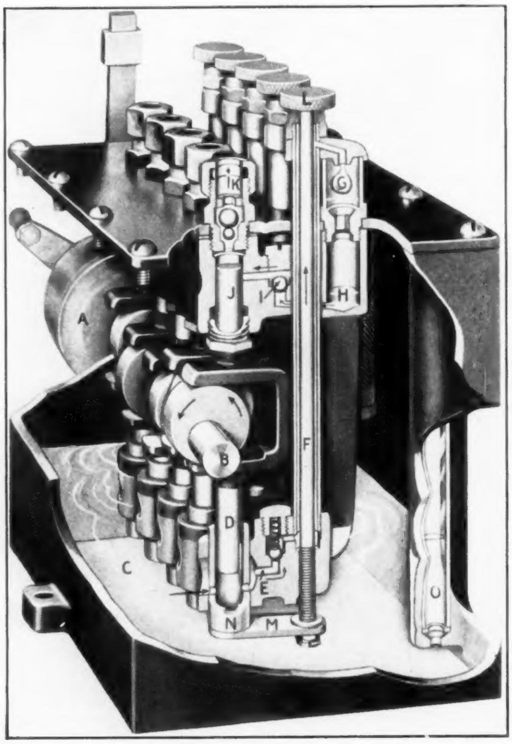
Steam cylinder oils must be of comparatively heavy body and possessed of high wetability in order to insure that the lubricating film will cling to the valve seat and cylinder walls, withstand washing off by the steam and resist the wearing or scraping effects of valves and pistons.

Viscosity or body is attainable by suitable refining; wetability is obtained by judicious treatment of the cylinder stock and the addition of certain fatty oils to obtain an emulsifying effect. As a general rule it will be essential to use an oil having a viscosity range of be-

tween approximately 100 and 220 seconds Saybolt at 210 degrees Fahr., according to the steam pressure and temperature involved, the type of steam valves and the means of application available.

Steam Distributes the Lubricant

The most efficient way of getting the lubricating oil to all desired points is to make use of the steam itself, which reaches all moving elements inside of the valve chambers and cylinders with the possible exception of parts of certain types of Corliss valves.



Courtesy of S. F. Bowser & Co., Inc.

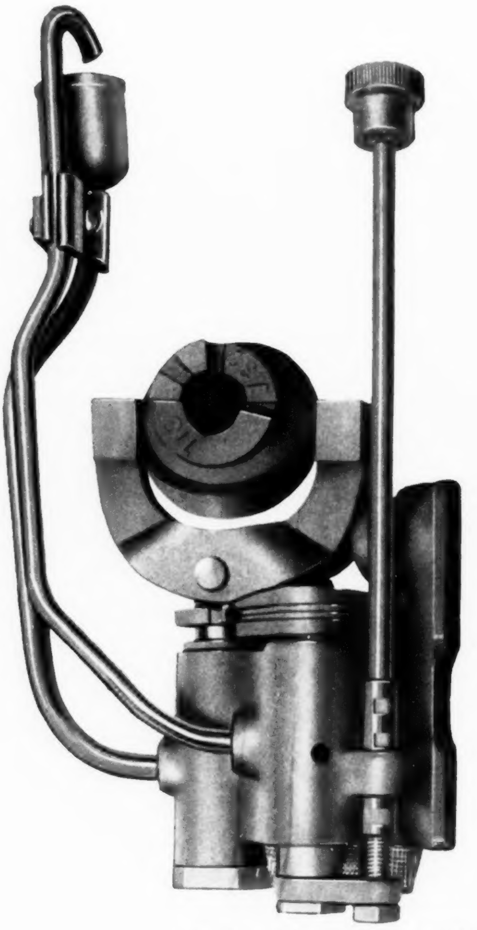
Fig. 1—Details of the pumping unit of the Bowser model "T" lubricator. Enclosed ratchet (A) rotates cam shaft (B), causing the yoke for each feed to move up and down. The oil in reservoir (C) is drawn into sleeve (N) by the upward stroke of recessed piston (D), which on its downward stroke closes the inlet port and forces the oil out through discharge port (E) past the ball check valve; thence upward and through drip nozzle in sight feed (G) into chamber (H); from this point it is drawn through check valve (I) by the downward stroke of piston (J) which, on the upstroke, forces the oil into discharge line (K). The quantity of oil discharged on each stroke can be individually regulated by turning knob (L), which raises or lowers sleeve (N) by means of bar (M).

If the oil is divided into minute globules and intimately mixed with the steam, only a very small quantity is required, and the degree of success in the atomization of the oil will control both the efficiency of lubrication and the quantity necessary.

The more complete the atomization and the more thoroughly the oil is dispersed through the steam, the better will be the lubrication of the engine and the more economical the consumption of oil. The degree of atomization of the oil is influenced by the condition of the steam, the point of introduction of the oil, the velocity of the steam, and the character of the oil.

Factors Affecting Atomization

Other things being equal, high steam pressure will produce quicker atomization of a given oil than low steam pressure, since high temperatures thin down the oil to a greater extent; so, a comparatively heavy bodied oil may be atomized by a high pressure steam as quickly as a light bodied oil will be atomized by a low pressure steam. Conversely, low pressure steam requires a lighter bodied oil in order to obtain efficient atomization. The



Courtesy of Madison-Kipp Corporation

Fig. 2—The Madison-Kipp model 50 pumping unit showing details of the sight feed tube, oil cup, the eccentric which develops oscillating and reciprocating motion in the plungers, the strainer and other pertinent parts.

point of introduction of the oil into the steam is also a factor, in that the farther this point is from the cylinder, the greater will be the opportunity for complete atomization.

Locating the Point of Introduction

If the oil is introduced directly into the valve chest or just above the throttle, a product must be used which will distribute itself very rapidly through the steam. On the other hand, if the point of introduction can be located from four to six feet from the cylinder, the oil does not have to be able to atomize so readily as there is more time for the steam to develop the necessary atomizing effect.

Further, if it is essential to use a heavy bodied oil to meet the cylinder conditions, better lubrication may be secured at a more economical cost by placing the introduction of the oil further back from the cylinder.

There is a limit, however, to this distance, for if the oil is injected into the steam too far from the cylinder, too much condensation of oil on the sides of the steam pipe will occur. This will increase the oil consumption, as the latter will run down into the steam chest without vaporizing. Ultimately, it may result in detrimental gummy or carbonaceous accumulations.

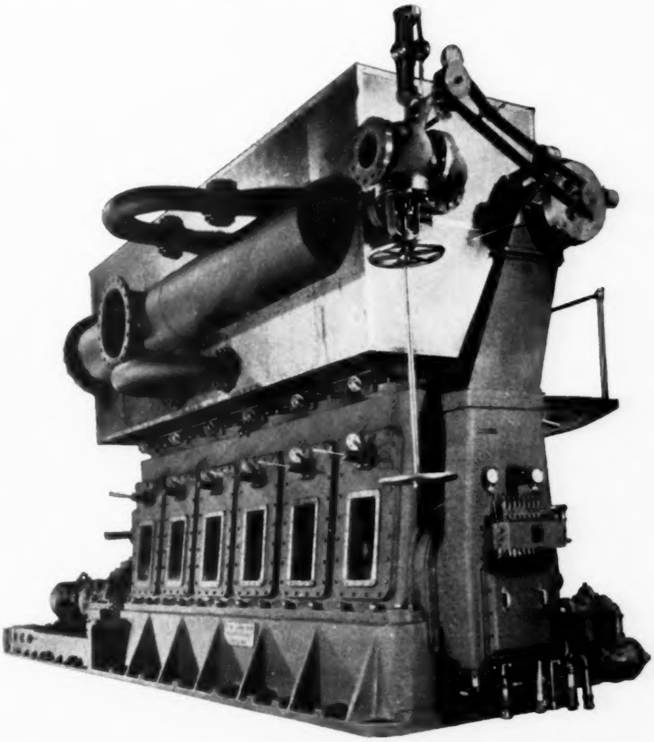
How to Judge Effective Cylinder Lubrication

The best evidence as to protective lubrication is the condition of the cylinder, valve seat and valve surfaces. If these appear to function without undue noise and if there is a light film of oil on the piston rod, the engine should be well lubricated. Some oil in the condensate is also a good indication.

Time is necessary for the lubricating film to form and function properly; so, a hasty decision as to the suitability of such an oil should never be made. Any test should cover a period of several weeks. Then the engine should be shut down and the cylinder head and valve chest cover removed to enable inspection of the interior. If there is evidence of a film of lubricant sufficient to penetrate and leave the time-honored brownish stain on three or four thicknesses of cigarette paper the surfaces may be regarded as being properly lubricated. Further evidence is a high polish and a color varying from bright iron-white to steel-blue.

Imperfect Lubrication

Rough, dry, dull or rusty surfaces indicate that lubrication has either been insufficient or the wrong grade of oil has been used. In addition, if the stain on the cigarette papers appears streaked, blackish or mottled, either the oil has been subject to carbonization or abnormal wear has taken place.



Courtesy of Manzel Brothers Company

Fig. 3—A six-cylinder Skinner 2,000 HP vertical marine unaflow engine equipped with an 8-feed Manzel Model "94" lubricator of the liquid sight feed type with rear ratchet drive.

Lack of lubrication will also sometimes be indicated by sticky valves or groaning sounds from the cylinder, when the engine is running. With Corliss valve systems slowness in action of the dash pots will be an indication that lubrication is imperfect.

Exhaust Steam an Indicator

The exhaust or condensate is oftentimes a good indicator of the extent to which cylinder and valve lubrication is being maintained. If the condensed steam shows considerable quantities of liquid oil, either too much oil is being fed or it is not properly atomized. If it shows minute drops of oil and is milky in color it is probable that atomization is complete and the feed is correct. If the piston rod shows a film of oil on it and there is no oil fed directly thereto it can be taken as an indication that atomi-

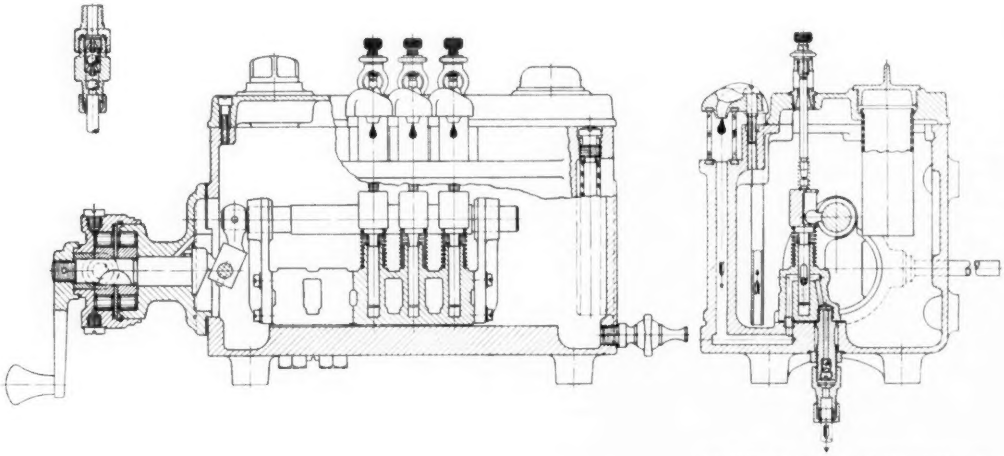
zation is satisfactory, and that the surfaces are receiving sufficient oil.

Pools of oil lying in the bottom of the cylinder or in the counterbore indicate excessive lubrication. This can only be determined, however, at the time of engine overhaul.

A suitable film on the piston rod, minute drops of oil and a milky appearance in the condensate, free action, and little or no noise in valve operation, are indications that the oil is suitable, atomization complete, and the rate of feeding is about right.

Conditions Which Affect Choice of Oil

The use of steam as a medium of power generation will involve a number of requirements from the viewpoint of lubrication, which are normally foreign to the operation of any equipment except the reciprocating steam engine, steam pump or compressor. Pressure, temperature and moisture must all be considered, for each will have a decided influence upon effective lubrication. There is more or less of a relation between these conditions, also the steam velocity and the use which is to be made of the exhaust.



Courtesy of Nathan Manufacturing Co.

Fig. 4—Sectional views of the Nathan Mechanical Lubricator, type DS1. No check valves are employed but the pistons are oscillated and reciprocated, controlling the intake and discharge ports. This movement is obtained by a horizontal sliding shaft guided by an eccentric through the operating lever of the ratchet and a reciprocating part of the engine. Where oil is to be discharged against back pressure to keep the feed lines filled with oil at all times, a terminal check is used. This makes oil instantly available for lubricating purposes when the engine is started.

Temperature Depends on Pressure and Superheat

The operating temperatures in the steam cylinder and valve chest must always be taken into consideration when we are selecting the initial characteristics of a cylinder oil. It can be noted from the steam tables that temperature is directly related to the pressure. As viscosity varies inversely with temperature it will be decreased as steam temperatures are increased. Where operating with high temperature saturated or superheated steam a heavier bodied oil should be used. Conversely, where steam pressures are low, or where a partial vacuum with accompanying low temperatures exist, a lower viscosity, more easily atomized oil is necessary.

The heat of the steam does not noticeably affect the rate at which a well refined cylinder oil will be oxidized. For example let us consider "the operating temperature" for saturated steam at, say, 600 pounds which is 486.6 degrees Fahr. This is below the open cup flash point of any cylinder oil. Furthermore, it is probable that the flash point would be raised with increased pressure. As a result, there does not seem to be any reason to believe that a very high flash or fire test is necessary. Saturated steam always contains moisture and as there is relatively little oxygen present in the steam it does not seem likely that ignition could be produced in the cylinder, regardless of the flash point of the oil. Even so, there are some who advocate using means for deoxidizing the steam and make-up feed water to retard corrosion of boiler tubes and steam lines.

Velocity Improves Atomization

Atomization of a cylinder oil is improved as the velocity and temperature are increased. In other words, the higher the temperature and velocity the more readily will a heavy bodied oil be atomized, due to the reduction in viscosity which occurs at the temperature of atomization. These conditions must there-

fore be taken into account when deciding on the initial viscosity of the oil.

Moisture Requires Compounding

The presence of moisture in steam will usually result in a film of straight mineral lubricating oil being rapidly washed off from the cylinder walls and other surfaces with which the steam comes in contact. Therefore, to secure proper lubrication under wet steam conditions it is necessary to either increase the rate of flow of the straight mineral oil, or else substitute an oil which contains a certain percentage of fatty compound such as lard oil, degras or tallow.

Steam will always contain a certain percentage of moisture unless it is superheated to a sufficient extent to counteract any line and cylinder condensation, which may be caused by the cooling effect of the piping or cylinder walls, and the expenditure of heat by the expansion stroke.

Compounding develops an emulsion through reaction of the compound with the moisture in the steam. The lubricating film thus has a greater affinity for the cylinder walls and other wearing surfaces and becomes more resistant to the washing action of the water in the steam. The greater the percentage of moisture in the steam the higher should be the fatty compound content of the lubricant, though ten to twelve percent is the usual maximum.

An excessive amount of fatty compound, beyond that necessary to form the requisite emulsion, will not improve the lubricating value of the oil. In fact, it may even be an objection as exposure to high temperatures may cause some fatty oils to decompose and form carbon and corrosive acids.

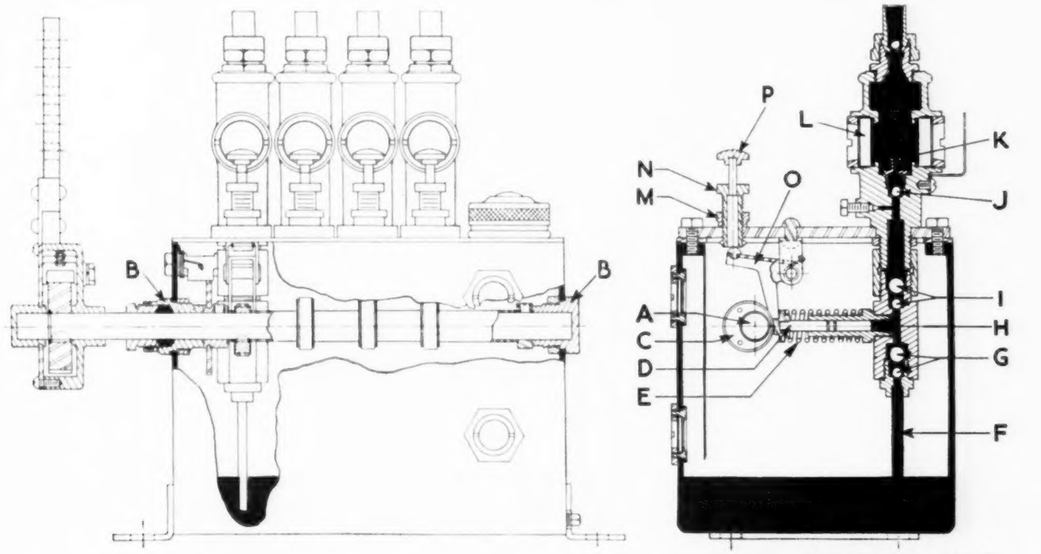
So, it is best to use only just enough compound to conform to the moisture conditions of the steam and maintain a suitable film of oil on the cylinder walls. In other words, it is best to reduce the quantity of compound and improve the quality.

Where Compounding is a Detriment

The property which causes compounded oils to unite with water to form emulsions in the cylinders also prevents ready separation from water in condensed steam; likewise, the more completely the oil is atomized the more difficulty will it have in separating from water. Obviously this will cause trouble where the condensate is used for makeup, or led to open feed water heaters.

Oil emulsions in a boiler combine with the boiler compounds to cause foaming, or with the boiler impurities to produce a coating over the tubes and fire surfaces. This coating seems to form more readily over clean tubes than over dirty ones. A very thin layer of oily sludge over a tube or shell surface will so insulate it that there is not only a large loss in heat efficiency, but the rise in temperature of the metal may be so excessive as to cause burning out or explosion of the boiler.

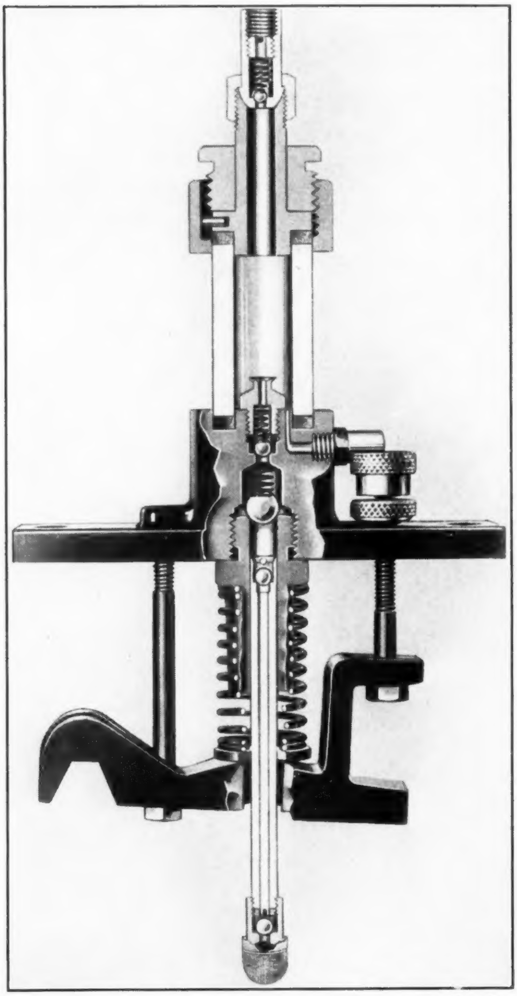
Even if exhaust steam is used only for heat-



Courtesy of The Torrington Mfg. Co.

Fig. 5—Working details of the Torrington mechanical lubricator. The eccentric shaft "A" is rotated by an external drive. Oil is delivered as plunger "D" moves forward, suction is accomplished by return spring "E". On the suction stroke oil flows through suction tube "F" past suction valves "G" and into cylinder "H". On delivery stroke oil is forced past discharge valves "I" and check valve "J" into sight feed body, which is filled with a transparent liquid. A drop forms on nozzle "K".

ing, the heaters may become coated with oil and lose in efficiency. This is also true if exhaust steam is used in tube and shell feed water heaters. Likewise, in condensing engines, an unsuitable oil will form layers on the condenser tubes with consequent loss of vacuum and thermal efficiency.



Courtesy of S. F. Bowser & Co., Inc.

Fig. 6—Cross-section of the Bowser 451 force feed lubricator pumping unit fitted with tubular sight glass. Oil passes straight upward.

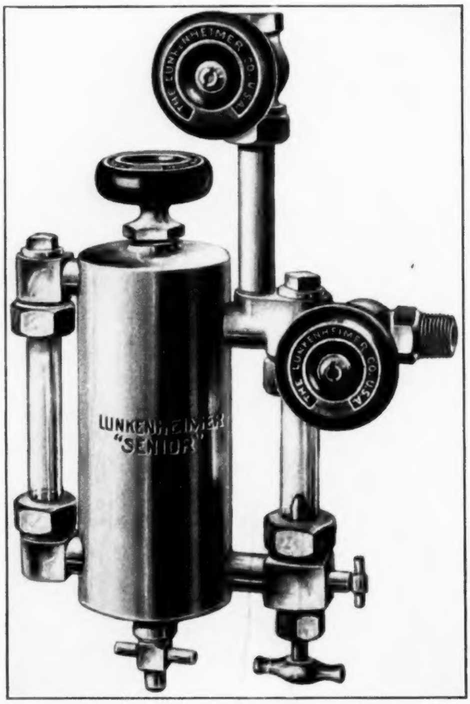
Where Straight Mineral Oils Apply

Where the presence of a fatty oil in the exhaust steam is objectionable it may then be advisable to resort to a straight mineral type of cylinder oil. One must remember that as an increased amount is necessary to insure proper lubrication, imperfect atomization may result. In consequence, oil accumulations in the cylinder will be prevalent and carbon deposits developed. This will be especially true in multiple expansion engines equipped with receivers and reheaters, the high temperatures to which the oil is subject being very conducive to carbonization. In poppet valve engines carbon formation of this nature may often cause imperfect operation of the valves. In any case, some carbon accumulations may form around the rings.

METHODS OF LUBRICATION

Modern practice in industry is to make use of the steam as an auxiliary lubricator, in the spreading of steam cylinder oils over valve seat and cylinder wall surfaces. This requires that the oil be fed into the steam line by a suitable lubricator, at a point between the throttle valve and steam chest.

This more dependable method of lubrication supplanted the idea of unit lubrication by individual oilers on the valve chest and cylinder, when the multiple expansion engine came into service. Then the theory of steam cylinder lubrication was revised to involve injecting oil by pressure into the steam line, using a hydrostatic or mechanical force feed lubricator.



Courtesy of The Lunkenheimer Co.

Fig. 7—The Lunkenheimer "Senior" hydrostatic lubricator designed for close regulation of the oil feed.

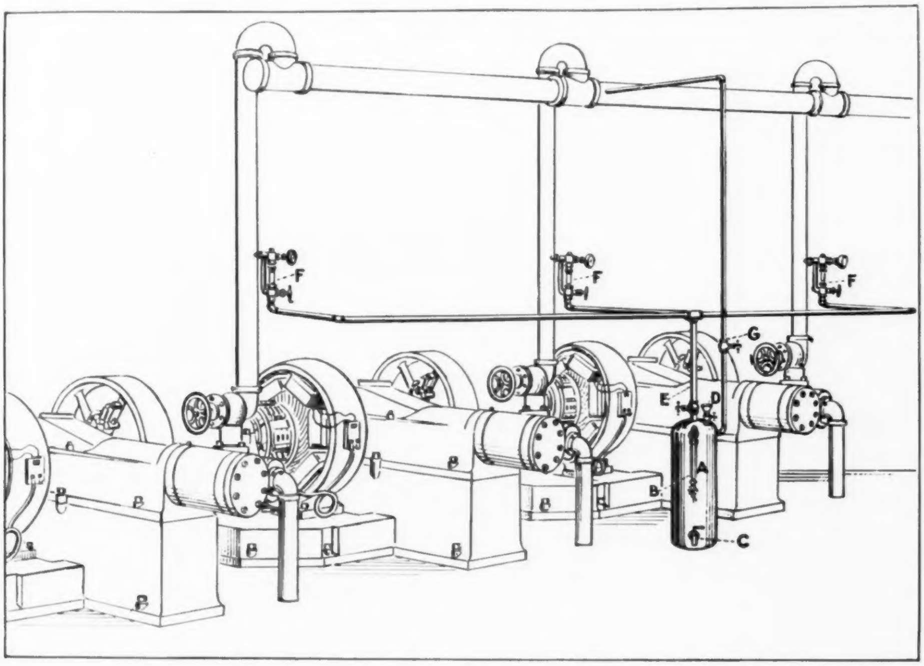
As the steam reaches practically all of the surfaces requiring lubrication in its passage

through the engine, it insures the transmission of the particles of oil which it carries to these parts. Sufficient oil, however, must be fed to the steam line and the point of introduction of the lubricant must be located at a suitable distance beyond the throttle valve and the steam chest to enable the steam to completely exercise its atomizing effect, for complete atomization is the secret of steam cylinder lubrication. If any of the oil is carried into the cylinder in liquid state its lubricating effect is lost, as it will either be swept out prematurely by the rush of exhaust steam, or be unable to distribute itself uniformly over the contact surfaces within the engine.

The Hydrostatic Lubricator

As the name implies, the hydrostatic lubricator forces oil drop by drop into the system by means of a head of water which is maintained by condensing of the steam; so flow of oil is intermittent, drops being fed into the steam line at intervals, depending on the adjustment of the regulating valve and the viscosity of the oil. A heavy bodied oil will flow through the sight glass slowly in large drops, while a lighter bodied oil will feed in smaller drops at more frequent intervals; the latter gives more complete and uniform dispersion of oil in the steam.

When the oil does not feed properly, or if it runs up the side of the glass, the feed will be obscured due to discoloration. This is frequently caused by using a steam type of gauge glass. If it is not possible to get a proper glass, the size of the drop may be reduced by filing down the lip on the feed valve and soldering a fine wire to the latter to allow the oil to follow the wire. If the oil backs up in the sight feed glass, it is usually due to insufficient pressure difference. This condition can be corrected by increasing the distance between the two connections into the steam pipe.



Courtesy of The Lunkenheimer Co.

Fig. 8—Showing a Lunkenheimer central tank multiple feed lubricating system. Note at "F" the "independent" sight feeds which deliver oil to each steam line.

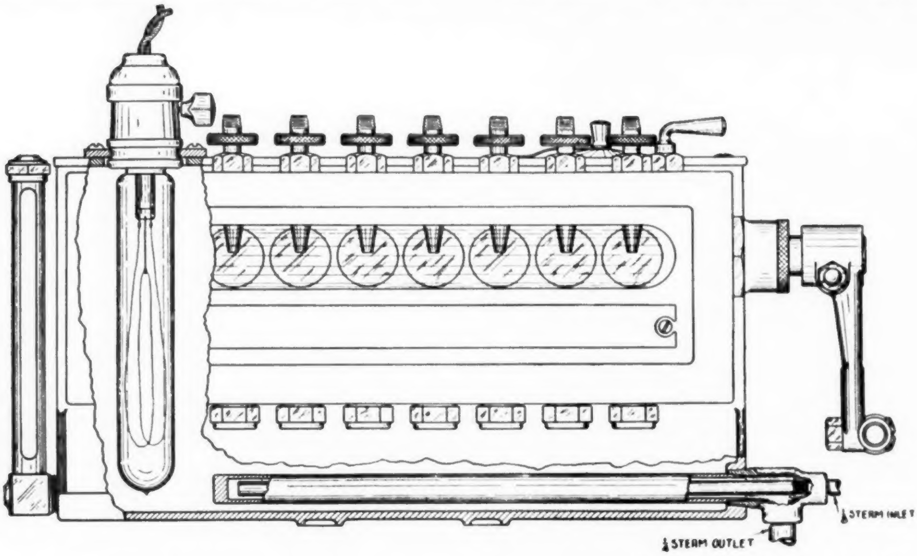
The dependability of the hydrostatic lubricator may also be affected in other ways. For example, a change in temperature will affect the viscosity of the oil, the size of the globules fed, and consequently the regularity of the flow. In addition, as the flow of oil will be independent of the speed of the engine, the cylinders may sometimes get too much or too little oil according to the location of the lubricator and the steam conditions.

Mechanical Force Feed Lubrication

The mechanical force feed lubricator is connected directly to some reciprocating part of the engine, pump or compressor. Consequently oil is fed into the system at a rate which varies directly with the speed of operation. This device functions only when the engine is operat-

ing, hence there is little possibility of wasted oil or flooding of the system.

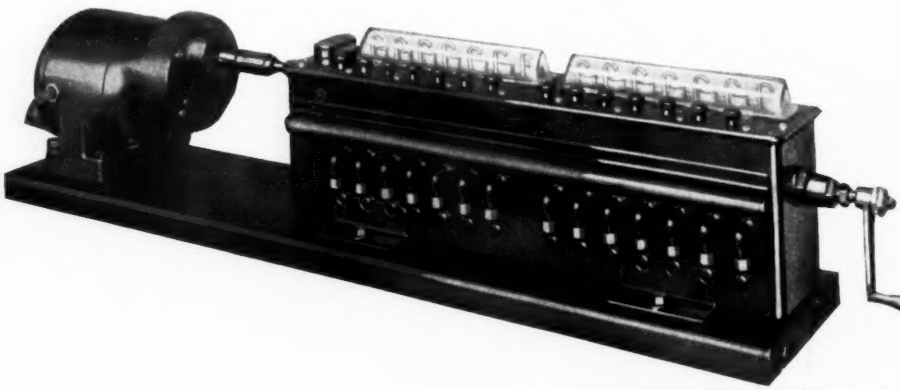
An efficient mechanical lubricator should



Courtesy of S. F. Bowser & Co., Inc.

Fig. 9—Showing the method of equipping a Bowser model "M" lubricator with either electric or steam heater.

feed the same amount of oil regardless of the temperature, viscosity or amount of oil in the reservoir. The quantity of oil delivered drop by drop is regulated by adjusting the length of the plunger stroke or the time required to complete a stroke. A short plunger stroke and



Courtesy of Madison-Kipp Corporation

Fig. 10—The Madison-Kipp model 50 motor-driven lubricator. Independent control is often very advantageous as to control of the lubricator, also location.

comparatively greater ratchet angle results in small discharges at frequent intervals.

Oil Temperature Control

Provisions for preheating the oil in the lubricator are necessary when engines and the steam ends of pumps or compressors are exposed to low temperatures, otherwise the oil may become so heavy as to cease to flow through the sight feeds to the plungers. Electric or steam heating coils are used for this purpose.

Pressure Conditions

When dealing with compound condensing engines operating at a pressure below atmosphere in the low pressure cylinder, the check valves on the discharge side of the lubricator should be spring loaded, otherwise the low pressure may cause the oil to be drawn out of the reservoir and into the cylinder in large quantities with great waste.

Atomization Essential for Distribution

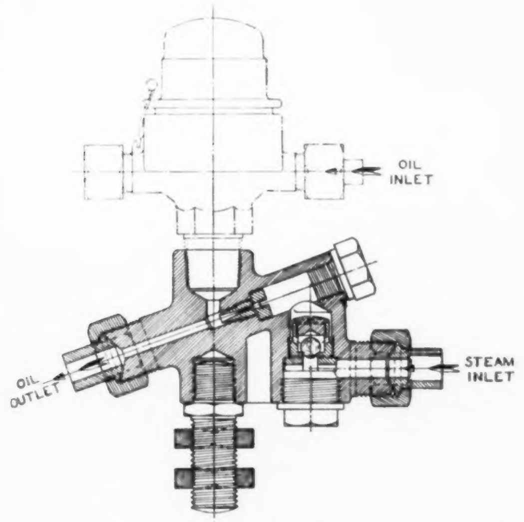
Complete dispersion of a cylinder oil through the body of the steam is assured by atomization. The lubricator merely serves to feed the

oil into the steam line; if this is assisted by a suitable atomizer, effective breaking up of the oil before it enters the steam chest and cylinders will be accomplished.

Atomizers are only effective, however, provided that they are properly designed and installed. Faulty construction or careless installation may frequently defeat any possibility of satisfactory lubrication, and oil will be consumed in a relatively useless manner due to improper distribution—in other words, wasted.

This means that the atomizer should be installed so that there are as few bends between it and the throttle valve as possible, as the steam, in striking the pipe at any bend, will throw out some of the oil onto the pipe where it may stick and run down the side.

If a steam separator is installed the oil should always be fed between the separator and the engine, otherwise the separator will remove a considerable part of the oil. Better atomization of any oil can be secured by feeding very small drops at frequent intervals than by feeding large drops less frequently.

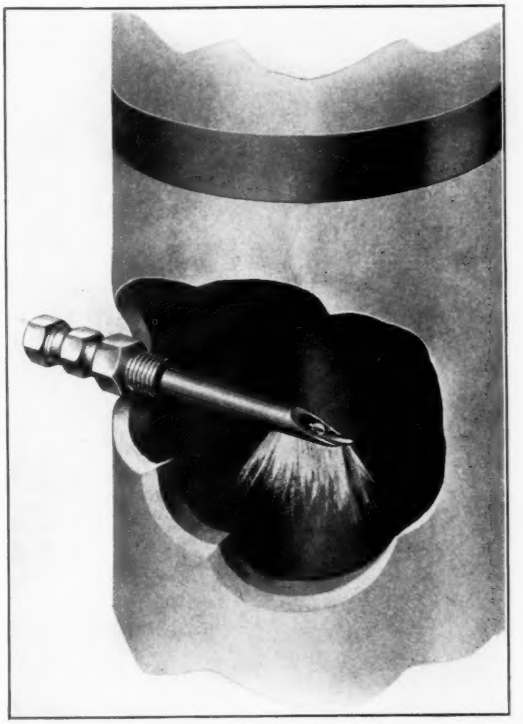


Courtesy of Nathan Manufacturing Co.

Fig. 11—Showing an improved type of Oil Atomizer where atomization takes place before the oil enters the steam pipe. An independent steam supply is led to the atomizer, usually taking the steam directly from the boiler with an independent operating valve which must be opened and closed manually. This small amount of steam discharged with high velocity from the atomizing nozzle, breaks up the oil into fine particles before it is carried into the steam pipe.

Even with the best of atomization, a considerable amount of oil which is carried by the steam never comes in contact with the metal surfaces. On the other hand, far less oil will be wasted when it is completely atomized than when it is introduced directly into the cylinder or valve chambers.

Efficient lubrication of the cylinders, walls and valve seats is our primary concern, and the oil should be selected with this in view. Then, the point of introduction must be studied with respect to the oil selected. If it requires correction and mechanical conditions



Courtesy of S. F. Bowser & Co., Inc.

Fig. 12—Showing method of installing a Bowser terminal check valve. Note how oil is atomized by action of the steam.

will permit, it should be changed to enable subsequent atomization to as complete a degree as possible. Many times, however, it is not feasible to locate the atomizer at the correct point; then it becomes necessary to compromise—adjusting the rate of delivery or even choosing another oil.

Installing Atomizers

The topside center of the atomizer should be clearly and permanently marked so that the slots are directly lined up with respect to the travel of the steam when the atomizer is installed; otherwise subsequent atomization will be impaired and the steam may be imperfectly lubricated.

Always avoid installing the atomizer upside down, for under such conditions, relatively no atomization will occur as the oil will simply drip from the nipple. It is the action of the steam, impinging on the oil as it flows out along the exposed portion of the nipple and

forcing it through the slots, which brings about the necessary atomization.

Types of Atomizers

There are two basic types of atomizers used today in power plant service. Each comprises a short length of pipe or a nipple inserted in the steam pipe, its outer end being connected to the lubricator delivery pipe.

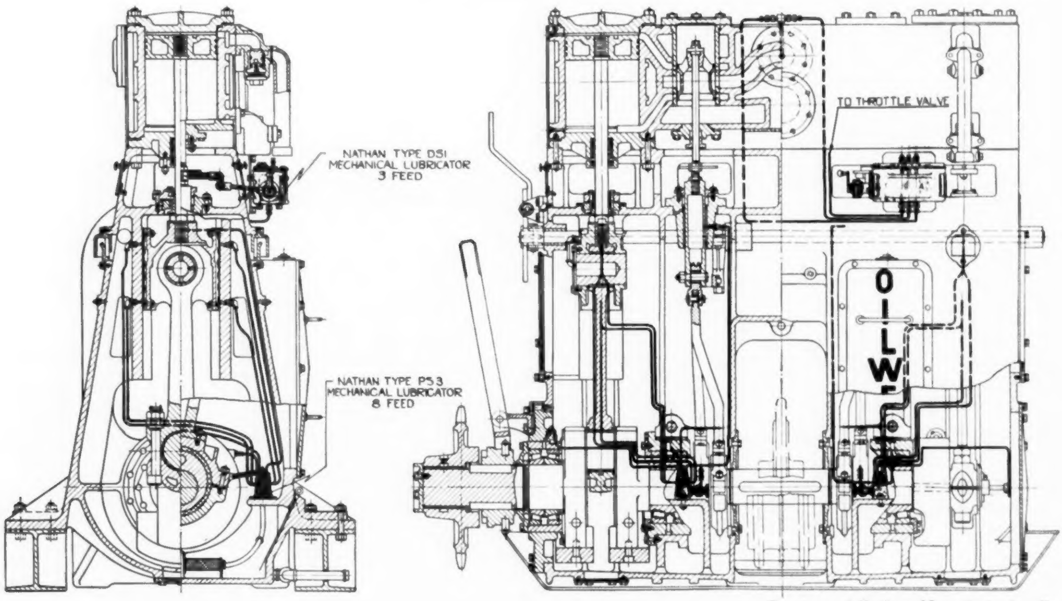
The Spoon Design

This is simply a piece of pipe or nipple of the same size as the lubricator discharge, and of such a length that when inserted in the steam pipe the tip will extend somewhat beyond the center line of the latter. Both ends of the nipple should be threaded; one end with a standard length thread, the other with a long enough thread to permit it to be screwed into the steam pipe.

The upper part of the long thread end of this nipple should be cut away on such an angle that the remaining section will have sufficient curvature to allow for the cutting of one or more slots parallel to the axis and from one to two inches long. The tip of this nipple should be bent to a spoon-shape, the slots preferably terminating at a sufficient distance from the end to insure against bending or loss of rigidity.

The Perforated Atomizer

This type of atomizer has a number of perforations instead of slots in the nipple. In this case, the nipple is usually not cut away, but remains intact, being drilled uniformly along the top and bottom (with respect to the axis) over perhaps a distance of two-thirds to three-quarters of the steam pipe diameter, with a sufficient number of equally spaced 1/8" to 1/4" holes. The top holes should preferably be somewhat enlarged.



Courtesy of Nathan Manufacturing Co.

Fig. 13—An assembly of Nathan Lubricators on a Vertical Steam Engine. The Steam cylinder lubricator has 3-feeds, two being used for lubricating the piston valves and cylinders through the steam pipe while one lubricates the throttle valve. Two bearing lubricators, each with 8-feeds, are mounted upon ledges over the oil sump in the crankcase. These take their oil through suction tubes provided with strainers directly from the sump. Each lubricator derives its motion from one of the eccentrics through a ratchet operating lever and cross-bar. The oil lines leading from the lubricator to the various bearings are clearly shown.

The nipple may or may not be threaded over its entire length according to the way it is to be installed and attached to the lubricator fitting. In some cases it is advisable to weld or plug up the end of this nipple which is inserted into the steam line; or, it can be carried through to the opposite side of the steam pipe.

The perforated atomizer should be quite as carefully installed as the spoon-shaped device, and every care should be taken to see that the holes are directly in line with the direction of flow of the steam in order that the latter may blow through and carry the oil out in a spray.

If, by chance, such an atomizer is installed so that the perforations point towards the walls of the steam pipe, the steam may not pass through, and atomization will not be effected. In this case, the atomizer will simply become an oil dripping device.

Atomizers of this type are not always effective even when properly installed due to the possibility of the holes becoming plugged up. To offset this, another type of perforated atomizer has holes drilled in the top of the

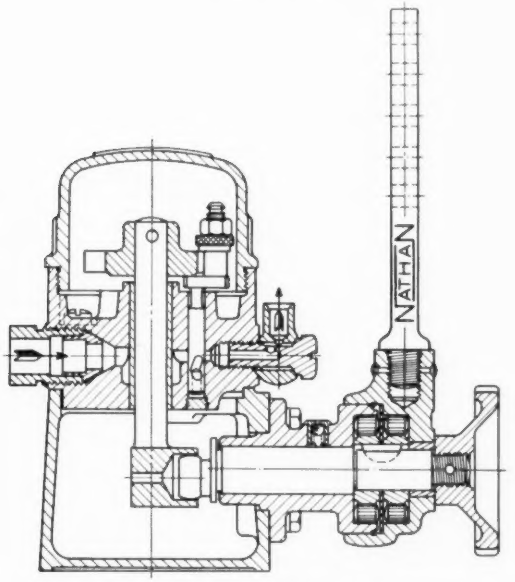
nipple only, the steam making a turn and carrying the oil out through the end.

Other Designs

Other types of atomizers less frequently used may consist of an open ended nipple, or a nipple drawn down to an orifice, and inserted into the steam pipe so that the oil just drips out into the steam. Whether much atomization actually occurs when oil is thus allowed to drip into a volume of high velocity steam is often a question. It might be expected that the drops of oil would be swept to the walls of the pipe to simply run down perhaps as far as the throttle valve.

Superheat Conditions

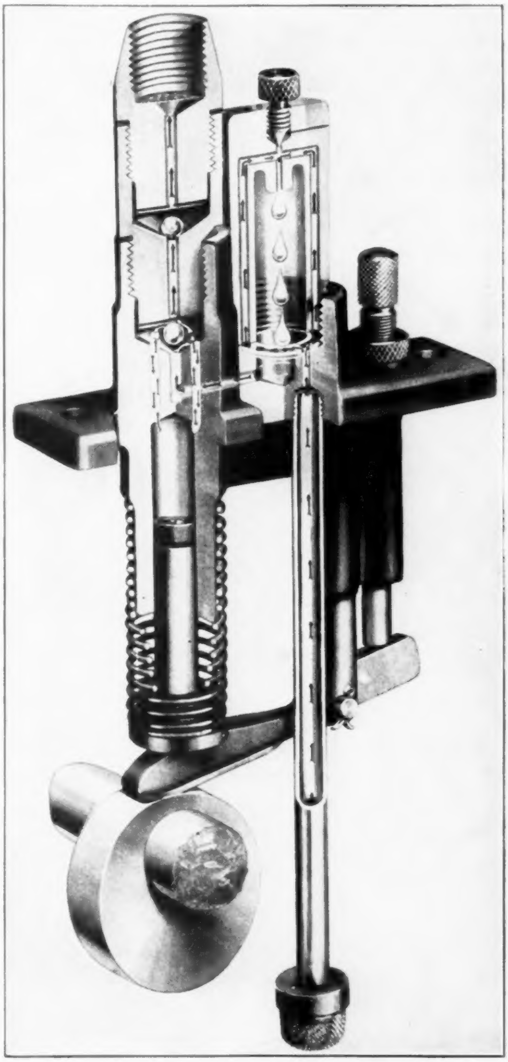
In planning for lubrication under superheated steam conditions, we must consider not only the comparatively high initial temperatures, but also the possibility of indeterminate moisture conditions due to condensation during a portion of the expansion stroke and over the entire exhaust stroke. Superheat seldom prevails throughout the engine. So, unless there is approximately 200 degrees initial superheat at the throttle practically no superheat will be left in the steam at the exhaust when operating at about one-quarter stroke. Consequently, instead of a purely superheated steam condition, we will have a dual problem to study in the selection of the most suitable steam cylinder oil, viz., initial superheat with subsequent saturation or moisture conditions.



Courtesy of Nathan Manufacturing Co.

Fig. 14—Sectional view of the Nathan Mechanical Lubricator type P. The oil reservoir is remote from the lubricator and supplies oil to a suction connection at the side of the instrument. The drive arm of the ratchet is connected to a reciprocating part of the engine operating a horizontal eccentric shaft which in turn reciprocates and oscillates a disc carrying pistons which by the same motion open and close suction and discharge ports, entirely eliminating valves.

As superheat requires high initial temperatures, we must be concerned with possible carbonization of some oils, and deposits on the valves at the end of the valve travel and at the end of the counterbore in the cylinders. Carbon deposition also will be accelerated by feeding an excess of oil to the cylinders.



Courtesy of Hills-McCanna Co.

Fig. 15—Showing the Hills-McCanna type VSF lubricator pump. Note how oil flows through the lucite glass. Arrows indicate flow of oil through the pump assembly.

Carbonization is caused by the oil remaining in contact with the hot surfaces and exposed to superheated steam long enough for any lighter

hydrocarbon constituents to be evaporated. The presence of air also causes an oil to carbonize. This means partial decomposition. If the lubricant is of such characteristics as to render it resistant to breakdown or oxidation and if it is fed to the cylinders in such small quantities that an accumulation of oil does not develop on the valves and other parts of the engine, carbon deposits should be of little concern.

Very often, however, it is necessary to use an excess of oil (over the amount required for saturated steam) especially when lubricating steam cylinders by straight mineral oils. Oils of this nature are usually of high viscosity and have high flash and fire points. Since they are lacking in compound they are suitable for the lubrication of the cylinder only as long as the steam remains dry or superheated; they cannot be depended upon to lubricate during that portion of the stroke when the steam is saturated because the subsequent moisture washes the oil off the cylinder walls. This will result in wear and increased friction due to dry walls.

So, many are apt to increase the rate of feed to obtain more dependable lubrication, but in so doing such a large amount of oil may be fed to the cylinders that it will not all be carried away. This will result in subsequent accumulation of carbon deposits.

The problem therefore becomes one of selecting an oil to meet the operating conditions. It is normally felt that a medium-heavy viscosity cylinder oil, having a fair amount of compounding, say perhaps 4 to 5 per cent prime lard oil or tallow, will be best. The resultant oil, on account of this compounding, will emulsify when necessary and thereby lubricate the cylinders very efficiently during that period when they are filled with saturated steam. As the per cent of compound is low no ill effects should result from exposure of the oil to superheat conditions. This is somewhat contrary to the usual understanding as to the properties necessary for an oil to withstand superheated steam, but the success which has attended the use of this type of oil makes the above explanation seem to be most reasonable and logical. Furthermore, it will give the most dependable lubrication, and when sparsely applied should develop a minimum of objectionable residues.

CYLINDER OIL IN THE EXHAUST

Use of the exhaust to obtain maximum benefit of its heat content is always advisable. According to conditions it may be used for process heating purposes, returned to a feed water heater or "just wasted." Obviously the latter should be avoided wherever possible in the interest of fuel conservation. An excess of cylinder oil in exhaust steam may cause trouble in open systems where perishable goods such as textiles may be involved. If returned to the boilers, on the other hand, certain lubricating constituents may give rise to deposits on tube surfaces, blistering and subsequent failure.

Utilization of steam heat for drying purposes in the textile industry, the manufacture of paper and the rubber trade, has led to considerable study of the temperatures which will normally prevail and which may impose severe duty upon the roll neck or journal bearings if these latter are not protected by suitable lubrication.

Lubrication of bearings subjected to steam heat becomes a problem due to the fact that the journals or roll necks of the heating elements are cored out for the purpose of admitting steam to the interior. The temperature will depend upon the rate of drying or amount of heat desired.

In the paper trade, steam as an adjunct to manufacture is first used in connection with the development of wood pulp in certain types of grinders preparatory to conversion into paper. The operation of the paper machine, in turn, requires a slow, even rate of heating, to avoid making a paper which may be brittle and to develop a stock which is comparatively air dry.

The rubber calender is another type of machine where an excess of temperature might be a detriment and yet where the surface of the dryer rolls must be maintained at a comparatively high degree to perform their function successfully.

The presence of an excess of cylinder oil in the exhaust, in any of the above mechanisms, would reduce the rate of heat transfer due to the probable accumulation of insulating layers on the inner surfaces of the drums or rolls.

CONCLUSION

To attain effective lubrication of steam cylinders one must have a thorough understanding of the operating conditions. Too often the value of the cylinder oil is lost sight of in connection with power plant maintenance. The petroleum chemist prepares steam cylinder oils to meet these conditions. His research has been exhaustive as he has had to consider both the chemistry of petroleum and the reaction of fats to heat and moisture, all under enclosed conditions in the engine where there is but little possibility of visual analysis of the degree of lubrication. The steam engineer can profit from this research by more careful selection of his cylinder oil to meet those conditions of operation which are presented by the design of his steam reciprocating machinery and the quality and temperature of his steam.

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TEXACO LUBRICATION RECOMMENDATIONS
FOR STEAM ENGINES

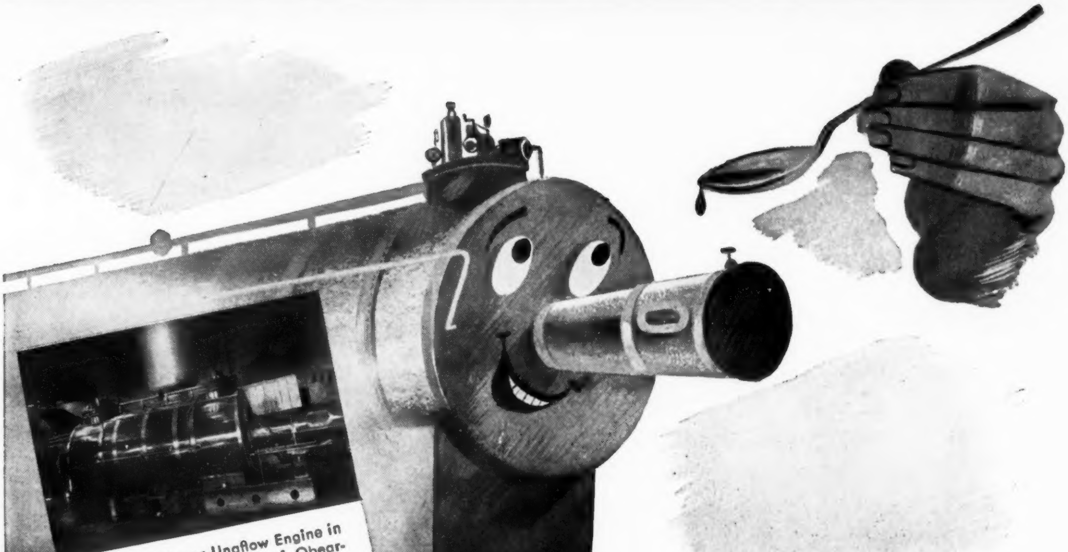
Steam Cylinders

SUPERHEATED STEAM CONDITIONS	**Texaco 650 T Cylinder Oil** **Texaco Cavis Cylinder Oil**
SATURATED STEAM: ABOVE 150 LBS. PRESSURE	
Where economy in use is possible	**Texaco Leader Valve Oil** **Texaco 650 T Cylinder Oil**
Where oil economy is secondary	**Texaco Honor Cylinder Oil** **Texaco Pinnacle Cylinder Oil** **Texaco Lyra Cylinder Oil**
SATURATED STEAM: BELOW 150 LBS. PRESSURE	
Where conditions of feed are good	**Texaco Honor Cylinder Oil** **Texaco Pinnacle Cylinder Oil** **Texaco Lyra Cylinder Oil**
Where atomization conditions are poor or rapid separation from exhaust steam is necessary	**Texaco Olympian Cylinder Oil** **Texaco Vanguard Cylinder Oil**
Where condensed steam is to be returned to boiler, used for the manufacture of ice or in other process work .	**Texaco Vanguard Cylinder Oil** **Texaco Olympian Cylinder Oil** **Texaco Vanguard Mineral Cylinder Oil** **Texaco Pinnacle Mineral Cylinder Oil**
Where rapid atomization is necessary, medium steam pressures and moisture conditions involved and oil feeds are close to steam chest, etc.	**Texaco Vanguard Cylinder Oil** **Texaco Olympian Cylinder Oil**
For low pressure wet steam conditions	**Texaco Draco Cylinder Oil** **Texaco Lyra Cylinder Oil**
Where excessive condensation prevails	**Texaco Leader Valve Oil**

Bearings, External Parts

SIGHT FEED OIL CUPS	**Texaco Anser Oil, Aleph Oil** **Texaco Altair Oil or Aries Oil**
GREASE LUBRICATION	**Texaco Cup Greases** **Texaco Star H Grease No. 00 or No. 1**
CIRCULATING SYSTEMS	
Normal conditions	**Texaco Canopus Oils** **Texaco Texol D or E**
Under adverse water conditions	**Texaco Regal Oil C or E**
CRANKCASE AND SPLASH OIL SYSTEMS	
Normal conditions	**Texaco Canopus Oils**
Under adverse water conditions	**Texaco Regal Oil B or C**

1200 Horsepower but they could *feed it with a teaspoon!*



1200-HP. Skinner Unaflow Engine in East St. Louis, Ill. plant of Obear-Nester Glass Co., kept at peak efficiency with Texaco.

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